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RESEARCH STUDY ON HEF FIRE FIGHTING

by

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The Laboratory has declared certain quantities of high energy fuels surplus. From this stock 50 pounds of HEF-2 was set aside for fire fighting tests. To determine the most useful course, a number of letters were sent to interested groups to determine what work had been done and what approaches might prove fruitful. A survey of these responses and an evaluation of our own ideas indicated that the program which we had proposed was too short range to yield worthwhile results since extensive studies had been made on HEF-2 and HEF-3 by Midwest Research and a new program has been undertaken by Rocketdyne on pentaborane. Therefore, it was decided to restrict the work to a paper study which is summarized in this report.

Information is available on boron compound fires covering alkylated borohydrides (HEF-2, HEF-3), pentaborane, and alkyl substituted boron (trimethyl boron, tributyl boron, etc). These compounds are pyrophoric or become so upon heating. This means that they should be disposed of as soon as possible after initial extinguishment before reignition can occur. The order of inflamibility appears to be: HEF-2, tributyl boron, HEF-3, triethyl boron and pentaborane.

Physical methods such as cooling with water or displacing oxygen by an inert atmosphere will extinguish, but the required application rates are very high and reignition is a problem.

Extinguishers containing halogens or carbonyl oxygen (e.g. CO_2, ketones, aldehydes, etc.) should be avoided since under some conditions explosive mixtures can be formed.

Foams are more effective than water sprays and they are particularly effective if an inert gas is used.

Some dry chemicals which have been tried on high energy fuel appear to be ineffective.

In general an ideal fire fighting agent would quench a borane fire or reduce it to a low level and then allow disposal of the material either by slow reaction or by absorption into inert material which could be handled and destroyed. Some commercial agents of this description are now available and are worth considering.

A number of interested groups offered suggestions. Their ideas were as follows:

The Air Force Fire Fighters at Andrews Air Force Base suggested trying: (1) A so-called "high expansion" (hair shampoo detergent) type of foam, aspirated with nitrogen. This is a test of essentially a new firefighting technique, that of super-expansion of foam bubble, using nitrogen for inflation; (2) sub-surface injection, and surface fine-spray separately using concentrated ammonium hydroxide. The sub-surface injection system will determine if intermediate reaction products with ammonium hydroxide are easier to extinguish than the burning boranes. The surface spray system is to determine the same thing occurring at essentially the flame-liquid interface.

The National Engineering Science Company is preparing a series of fluorinated esters of inorganic acids. These non flammable materials dissolve pentaborane. They feel that by diluting pentaborane non flammable mixtures may be produced.

Ansul Chemical Company markets a material called "Met-L-Kyl." It is a dry chemical composed of a mixture of bicarbonate base dry chemical and an activated absorbent. This mixture, when discharged on metal alkyl fires, extinguishes the flames and absorbs the spilled fuel so that control is established. This material has been successfully used on aluminum alkyls.

Hydrolysis of pentaborane is slow with cold water but in fire situations the rate would be greatly increased. Midwest Research Institute believes that the hydrolysis and/or complexing of pentaborane have merit in decontamination techniques. For example, the rate of hydrolysis can be greatly accelerated by the use of dioxane-water mixtures. Such decontamination reactions with respect to their potential utility as supplements should be investigated.

The shock sensitivity of boron hydrides with halogenated organic materials is well documented.[1] In addition, boron hydrides form explosive mixtures with organic compounds containing carbonyl groups. In Midwest's work with HEF-2, it was demonstrated that complexing agents could be successfully blended with fire fighting foams. However, the shock sensitivity of products derived from extinguishing agents selected for tests with pentaborane should be carefully evaluated so that no new hazards will be introduced.

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[1] "The Handling and Storage of Liquid Propellants," published by the Liquid Propellant Information Agency at APL/JHU, March, 1961.

In regard to hydrolysis of pentaborane it should be noted that the end products of the boranes and water are boric oxides and hydrogen. With ammonia and ammonium compounds complexes are formed which yield BN and hydrogen. Under some conditions these additives are explosive and shock and friction sensitive. It should be realized that these hydrolysis reactions generate hydrogen which may be as bad or worse than the borane. For example, one pound of pentaborane will yield .38 pound of hydrogen.

Callery Chemical Company suggests trying a conventional dry chemical extinguisher agent, to which has been added 5 to 10 per cent of potassium iodide or ammonium iodide. If the ignition characteristics of HEF-2 are dependent on chain branching, the iodine content in the dry chemical may exhibit its properties markedly and make it easier to put out a fire of it permanently.

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(1) Mr. Martin Casey of the Air Force

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(6) Mr. herbert Voltz of Callery Chemical Company

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